II. REMARKS

Claims 12, 18, 19, 23, 24, 26 and 27 have been amended by the present paper. More specifically, claims 12, 18, 19, 24, 26 and 27 have been amended to improve grammar, form, and/or to address typographical errors, which has no further limiting effect on the scope of these claims. Independent claim 12 has been further amended to replace the phrase "a secondary pulse train" with the phrase --a train of secondary pulses-- as supported by Figure 3 and on page 4, lines 33-36, of Applicants' disclosure as originally filed. Claim 12 has been further amended to recite that "each secondary pulse has a shorter length than the corresponding primary pulse" as supported by Figure 3 and on page 4, lines 10-23, of Applicants' disclosure as originally filed. These amendments to claim 12 only state more clearly what was already contained in the phrase "a secondary pulse train."

Claim 23, which depends upon claim 21, has been amended to delete a particular embodiment of the crystal. Therefore, the present amendment actually broadens the scope of claim 23.

New claim 28 depends upon claim 12 and additionally recites that "said modulation means comprises a Pockels cell" as supported on page 3, line 8, of Applicants' specification as originally filed.

New independent claim 29 incorporates subject matter from previous claims 12, 14, 18, 21 and 23, and additionally recites "a train of secondary pulses" and "each secondary pulse has a shorter length than the corresponding primary pulse" as supported by Figure 3 and on page 4, lines 10-23 and lines 33-36, of Applicants' disclosure as originally filed.

The present amendment adds no new matter to the above-captioned application.

A. The Invention

The present invention pertains broadly to a laser machining device such as may be used to drill holes in fluid injection device components, for example, such as are used for injecting fuel into a combustion engine. In accordance with an embodiment of the present invention, a laser machining device is provided that includes features recited by independent claim 12. In accordance with another embodiment of the present invention, a laser machining device is provided that includes features recited by independent claim 29. Various other embodiments of the present invention are recited in the dependent claims.

An advantage provided by the various embodiments of the present invention is that a laser machining device is provided that may be used to drill holes in fluid injection device components, for example, wherein the laser machining device has good operating stability, a high level of hole machining precision, and allows the holes to be machined at a relatively high speed to obtain a high industrial yield.

B. The Rejections

Claims 12, 13 and 24 stand rejected under 35 U.S.C. §103(a) as allegedly unpatentable over Kyusho et al. (U.S. Patent Application Publication No. US 2002/0009843 A1, hereafter the "Kyusho Publication") in view of Wang et al. (U.S. Patent 6,414,980, hereafter the "Wang Patent"). Claims 14, 15, 18 and 19 stand rejected under 35 U.S.C. §103(a) as allegedly unpatentable over the Kyusho Publication in view of the Wang Patent, and further in view of Yoda et al. (U.S. Patent 6,539,035, hereafter the "Yoda Patent"). Claim 16 stands rejected under 35 U.S.C. §103(a) as allegedly unpatentable over the Kyusho Publication in view of the Wang Patent, and further in view of Von Allmen et al. (U.S. Patent 4,114,018, hereafter the "Von Allmen Patent"). Claim 17 stands rejected under 35 U.S.C. §103(a) as allegedly unpatentable over the Kyusho Publication in view of the Wang Patent,

and in view of the Yoda Patent, and further in view of the Von Allmen Patent. Claims 20 and 21 stand rejected under 35 U.S.C. §103(a) as allegedly unpatentable over the Kyusho Publication in view of the Wang Patent, and in view of the Yoda Patent, and further in view of Freitas (U.S. Patent 5,828,683, hereafter the "Freitas Patent"). Claim 22 stands rejected under 35 U.S.C. §103(a) as allegedly unpatentable over the Kyusho Publication in view of the Wang Patent, and further in view of Kuwabara et al. (U.S. Patent 5,381,437, hereafter the "Kuwabara Patent"). Claim 23 stands rejected under 35 U.S.C. §103(a) as allegedly unpatentable over the Kyusho Publication in view of the Wang Patent, and in view of the Yoda Patent, and in view of the Freitas Patent, and further in view of Tatsuno et al. (U.S. Patent 5,377,212, hereafter the "Tatsuno Patent"). Claims 25-27 stand rejected under 35 U.S.C. §103(a) as allegedly unpatentable over the Kyusho Publication in view of the Wang Patent, and further in view of Forsman et al. (U.S. Patent 6,664,498 B2, hereafter the "Forsman Patent").

Applicants respectfully traverse the Examiner's rejections and request reconsideration of the above-captioned application for the following reasons.

C. Applicants' Arguments

A prima facie case of obviousness requires a showing that the scope and content of the prior art teaches each and every element of the claimed invention, and that the prior art provides some teaching, suggestion or motivation, or other legitimate reason, for combining the references in the manner claimed. KSR International Co. v. Teleflex Inc., 127 S.Ct. 1727, 1739-41 (2007); In re Oetiker, 24 U.S.P.Q.2d 1443 (Fed. Cir. 1992). In this case, the Examiner has failed to establish a prima facie case of obviousness against Applicants' claims 12-29 because the combination of the Kyusho Publication, the Wang Patent, the Yoda Patent, the Von Allmen Patent, the Freitas Patent, the Kuwabara Patent, the Tatsuno Patent and the

Forsman Patent still fails to teach, or suggest, (i) "said resonator generates primary pulses having a length within or greater than the microsecond range," (ii) "modulation means arranged between said resonator and a machining head, wherein said modulation means receives primary pulses from said resonator and operates to output a train of secondary pulses for each primary pulse entering therein from said resonator," and (iii) "each secondary pulse has a shorter length than the corresponding primary pulse" as recited by independent claims 12 and 29.

i. The Kyusho Publication

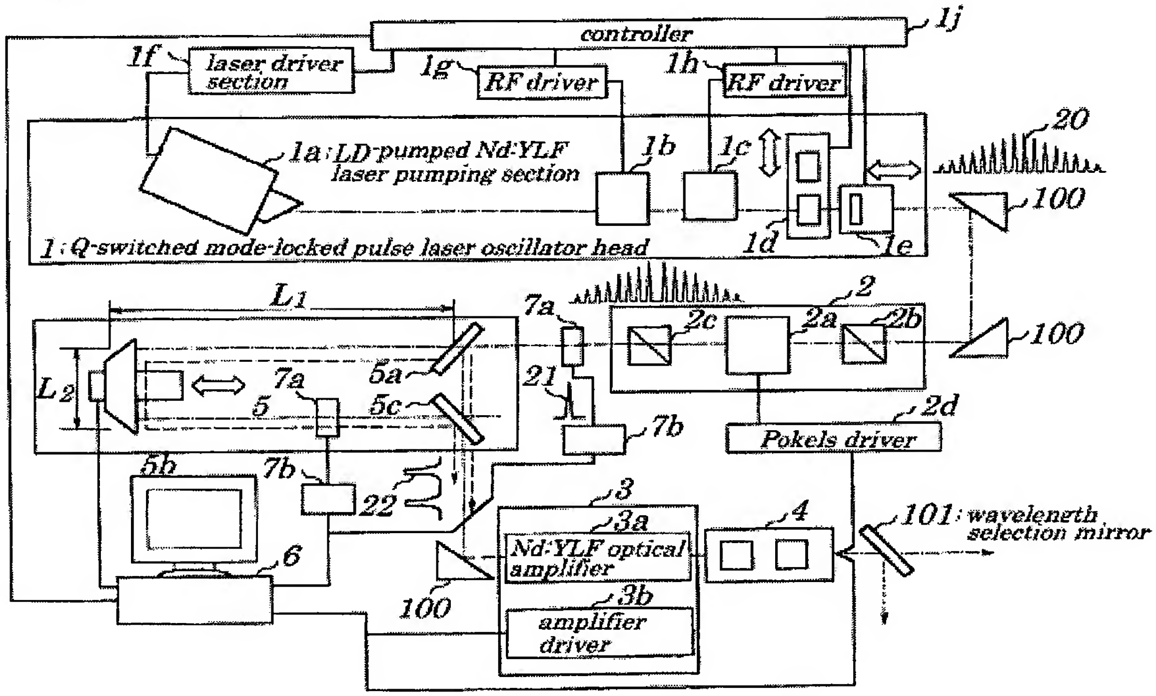
The Kyusho Publication discloses a "method for repairing pattern by laser and laser-based pattern repair apparatus," wherein the method for repairing a pattern by using a laser and the laser-based pattern repair apparatus are capable of reducing splashes, rolling-up, and damage to a glass substrate to a minimum in pattern defects repairing processing by removing a thin metal layer such as a chromium layer (See Abstract of the Kyusho Publication). According the Kyusho Publication, a part of a string of pulses is obtained by slicing, using an optical shutter, pulses from laser light having a pulse width of 10 ps to 300 ps emitted from a Q-swiched mode-locked pulse laser, which is used to produce multi-pulses that are divided into two portions in terms of time base correction using an optical delaying unit (See Abstract of the Kyusho Publication). The laser-based repair apparatus according to the Kyusho Publication is schematically shown in Figure 1, which is reproduced below for the Examiner's convenience.

According to Figure 1 of the Kyusho Publication, the laser-based repair apparatus includes a laser pumping section (1a) and an ultrasonic modulator (1c), (Kyusho Publication, ¶ [0141]). The Examiner contends that the structure labeled by the character reference "4" in Figure 1 is a "resonator" (Office Action, dated March 30, 2009, at 2, lines 21-22). Applicants

disagree because the specification of the Kyusho Publication identifies structure "4" as a "wavelength conversion element" (Kyusho Publication, ¶ [0141]), which has nothing to do whatsoever with a pulse modulator. A pulse modulator acts on the pulse profile and not on the laser wavelength. Furthermore, the Kyusho Publication discloses that there is an optical resonator within head (1), which is defined by or between the total reflection mirror of section (1a) and the output mirror (1e), (Kyusho Publication, ¶ [0141]).

When the Patent Office asserts there is an explicit or implicit teaching in the prior art, the Patent Office must indicate where such teaching appears in the reference. In re Rijckaert, 28 U.S.P.Q.2d 1955, 1957 (Fed. Cir. 1993). In this case, the Examiner contends that the Kyusho Publication discloses that the structure labeled "4" in Figure 1 is a "resonator." The Examiner must indicate specifically where in the disclosure of the Kyusho Publication it is disclosed that character reference "4" in Figure 1 is a "resonator." Otherwise, the Examiner must concede that the Kyusho Publication does not teach, or suggest, that the structure labeled in Figure 1 of the Kyusho Publication is a "resonator."

FIG.1



The Kyusho Publication does not teach, or even suggest, (i) "said resonator generates primary pulses having a length within or greater than the microsecond range," (ii) "modulation means arranged between said resonator and a machining head, wherein said modulation means receives primary pulses from said resonator and operates to output a train of secondary pulses for each primary pulse entering therein from said resonator," and (iii) "each secondary pulse has a shorter length than the corresponding primary pulse" as recited by independent claims 12 and 29. Furthermore, as conceded by the Examiner (Office Action, dated March 30, 3009, at 2, line 23, to 3, line 3; at 3, lines 9-12; at 3, lines 17-19; at 4, lines 17-20; at 5, lines 3-6; and at 5, lines 10-12), the Kyusho Publication does not teach, or suggest, (iv) "said first optical pumping means is formed by laser diodes" as recited by claims 12 and 29, (v) "means for amplifying the pulses supplied by said resonator" as recited by claim 14, (vi) "said optical diode is formed by a linear polarizer and by a quarter-wave plate arranged following said polarizer" as recited by claim 16, (vii) "said resonator is arranged for supplying at the outlet thereof a linearly polarized laser beam" as recited by claim 22, (viii) "said first active medium is formed by a crystal selected from among crystals that directly generate a linearly polarized light" as recited by claim 23, and (ix) "each of the primary pulses has a length between fifty microseconds (50 μs) and one millisecond (1 ms)" as recited by claim 25.

ii. The Wang Patent

The Wang Patent discloses "laser rod thermalization," which includes a method for operating an extracavity frequency-converted solid-state laser for performing a laser processing operation (See Abstract of the Wang Patent). As shown in Wang's Figure 1 (reproduced below for the Examiner's convenience), the laser has a laser-resonator (22) including an optically-pumped gain-medium, and the resonator is configured to compensate

for a predetermined range of thermal lensing in the gain-medium (See Abstract of the Wang Patent). An optically-nonlinear crystal located outside the resonator converts fundamental laser radiation delivered by the resonator (22) into frequency converted radiation (See Abstract of the Wang Patent). The laser processing operation is performed by a train of pulses of the frequency-converted radiation having sufficient power to perform the processing operation (See Abstract of the Wang Patent). The power of frequency-converted radiation is dependent on delivery parameters of the laser radiation from the laser-resonator (22), and the laser is operated so that the resonator delivers effectively the same average power of fundamental laser radiation before and during the laser processing operation (See Abstract of the Wang Patent). According to the Wang Patent, this provides that thermal-lensing in the gain-medium is within the predetermined range before and during a laser

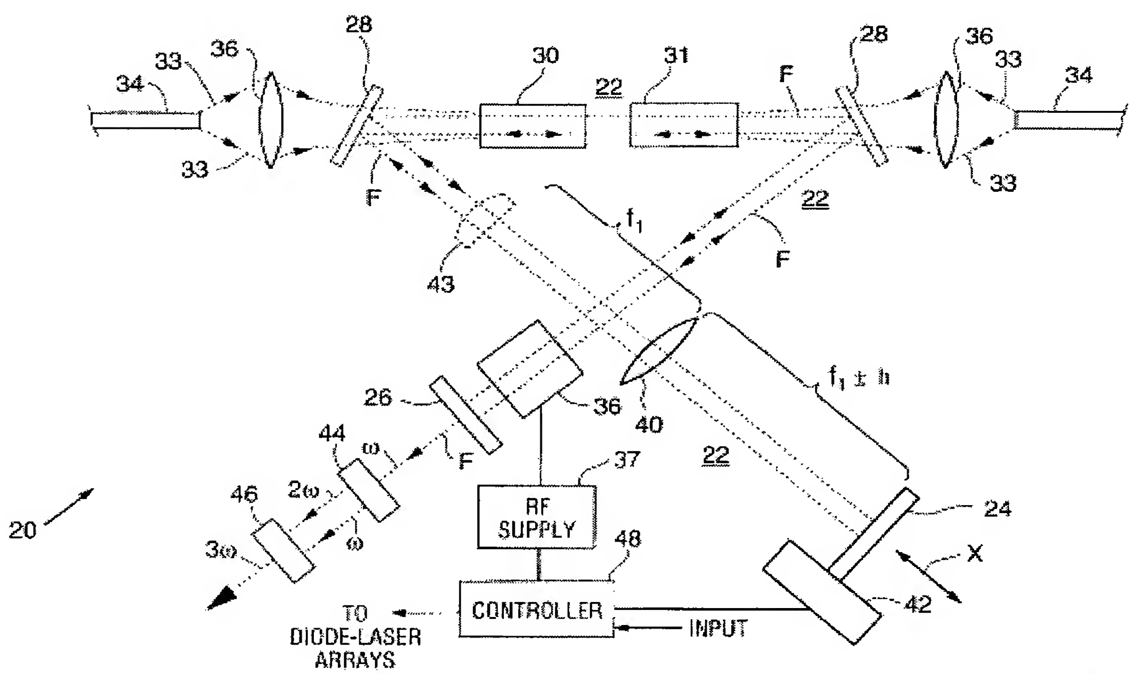


FIG. 1

processing operation (See Abstract of the Wang Patent). Delivery parameters of the laser radiation before and during the processing operation are varied such that power of frequency-

converted radiation generated before the processing operating is insufficient to perform a laser processing operation (See Abstract of the Wang Patent).

However, the Wang Patent does not teach, or even suggest, (i) "said resonator generates primary pulses having a length within or greater than the microsecond range," (ii) "modulation means arranged between said resonator and a machining head, wherein said modulation means receives primary pulses from said resonator and operates to output a train of secondary pulses for each primary pulse entering therein from said resonator," and (iii) "each secondary pulse has a shorter length than the corresponding primary pulse" as recited by independent claims 12 and 29. Furthermore, as conceded by the Examiner (Office Action, dated March 30, 3009, at 3, lines 9-12; at 3, lines 17-19; at 4, lines 17-20; at 5, lines 3-6; and at 5, lines 10-12), the Wang Patent does not teach, or suggest, (iv) "means for amplifying the pulses supplied by said resonator" as recited by claim 14, (v) "said optical diode is formed by a linear polarizer and by a quarter-wave plate arranged following said polarizer" as recited by claim 16, (vi) "said resonator is arranged for supplying at the outlet thereof a linearly polarized laser beam" as recited by claim 22, (vii) "said first active medium is formed by a crystal selected from among crystals that directly generate a linearly polarized light" as recited by claim 23, and (viii) "each of the primary pulses has a length between fifty microseconds (50 μs) and one millisecond (1 ms)" as recited by claim 25.

iii. The Yoda Patent

The Yoda Patent discloses a "laser transmission system" for transmitting a laser beam to an optical fiber, wherein the system comprises a pulse laser oscillator unit, a beam guide unit having an optical condensing unit for condensing a pulse laser beam radiated from the pulse laser oscillator unit, an optical fiber unit for transmitting the pulse laser beam condensed by the optical fiber beam guide unit, and a device for reducing a coherence of the

pulse laser beam provided for at least one of the pulse laser oscillator unit, the beam guide unit and the optical fiber unit (See Abstract of the Yoda Patent). According to the Yoda Patent, the coherence reducing device is for making substantially uniform distribution of laser beams at a beam entrance portion of the optical fiber unit and for preventing the laser beams from focusing or converging on one point in the optical fiber unit (See Abstract of the Yoda Patent). The Yoda Patent further discloses that a pulse laser oscillator unit (10a) comprises a laser resonator (15) and a beam amplifier (16), wherein the beam amplifier (16) amplifies the pulse laser beam L_1 from the laser resonator (15) into pulse laser beam L_2 (Yoda Patent, col. 5, lines 53-63).

iv. <u>The Von Allmen Patent</u>

The Von Allmen Patent discloses a "method for ablating metal workpieces with laser radiation," which pertains to a technique for ablating a metal workpiece by the use of laser beam radiation at an efficiency higher than previously possible and an improved regulation of the ablation process (See Abstract of the Von Allmen Patent). The Von Allmen Patent discloses eliminating undesired side effects of the ablation process by the entire and complete ejection of the molten metal at the point of beam impingement so that no material remains on the workpiece in the areas between contiguous points of ablation (See Abstract of the Von Allmen Patent). The Von Allmen Patent also discloses the appropriate selection of beam intensity and the selection of pulse shape in accordance with the disclosed method (See Abstract of the Von Allmen Patent). The Von Allmen Patent discloses a lasing system in Figure 6, which includes an optical diode (18) that may include an additional polarizer and a quarter-wave plate (Von Allmen Patent, col. 6, lines 8-10 and lines 54-58).

v. The Freitas Patent

The Freitas Patent discloses a "high density, optically corrected, micro-channel cooled, V-groove monolithic laser diode array," that achieves stacking pitches to 33 bars/cm by mounting laser diodes into V-shaped grooves, and that this disclosed design delivers >4kW/cm^2 of directional pulsed laser power (See Abstract of the Freitas Patent). The Freitas Patent discloses that the optically corrected, micro-channel cooled, high density laser is usable in all solid state laser systems that require directional, narrow bandwidth, high optical power density pump sources (See Abstract of the Freitas Patent). The Freitas Patent discloses the use of laser diode arrays to optically excite, or "pump," a crystal host and offer a narrow band of emission, compactness, high electrical efficiency, and higher reliability compared to flash lamps (Freitas Patent, col. 1, lines 17-29).

vi. The Kuwabara Patent

The Kuwabara Patent discloses a "high-power solid-state laser resonator," which is allegedly capable of outputting a high power linearly polarized laser beam, in which a laser beam subjected to the birefringence in the laser resonator is effected to minimize a component of the laser beam that is orthogonal with the direction of polarization definable by a Brewster plate upon traversing a quarter-wave plate, which enables the linear polarization output distribution of the laser beam to become uniform (See Abstract of the Kuwabara Patent).

vii. The Tatsuno Patent

The Tatsuno Patent discloses a "solid-state laser device including uniaxial laser crystal emitting linearly polarized fundamental wave and nonlinear optical crystal emitting linearly polarized harmonic wave," which pertains to a short-wavelength laser having a stable

output and an optical information processing system capable of high-density recording, wherein the solid-state laser is used as a light source, and a nonlinear optical crystal is arranged in a resonator in order to produce a short wavelength by means of a solid-state laser (See Abstract of the Tatsuno Patent). The Tatsuno Patent discloses that retardation of the nonlinear optical crystal is controlled by determining the length of the nonlinear optical crystal, and that the solid-state laser device has a stable output with the noise removed from a pumping power light source (See Abstract of the Tatsuno Patent). The Tatsuno Patent further discloses that the solid-state laser device is used as a light source for an optical information processing system, and the light of irrelevant wavelengths contained in the light from the solid-state laser device are removed by a device having the ability to select wavelengths; thus, not only a stable light source with a short wavelength but also an optical information processing system capable of high-density recording are realized (See Abstract of the Tatsuno Patent). The Tatsuno Patent also discloses a linearly polarized Nd:YVO solid laser 1064 nm in wavelength and that if a KTP crystal is placed in a resonator of the Nd:YVO solid laser, then the retardation would disturb the linear polarization of the Nd:YVO solid laser into elliptic polarization (Tatsuno Patent, col. 5, lines 38-50).

viii. The Forsman Patent

The Forsman Patent discloses a "method and apparatus for increasing the material removal rate in laser machining" in which the methods and apparatus for material modification use laser bursts that include appropriately timed laser pulses to enhance material modification (See Abstract of the Forsman Patent). According to the Forsman Patent, a method for material modification comprises the steps of: (i) providing bursts of laser pulses, wherein each burst comprises at least two laser pulses, wherein each laser pulse has a pulse duration within a range of between approximately 10 ps and 100 ns, wherein a time between

each laser pulse of each burst is within a range of between approximately 5 ns and 5 μs; (ii) a time between successive bursts is greater than the time between each laser pulse comprising each burst; and (iii) directing the bursts upon a workpiece, wherein an intensity of a primary laser pulse of each burst exceeds a damage threshold of the workpiece (See Abstract of the Forsman Patent). The Forsman Patent discloses using two appropriately timed laser pulses, including a primary pulse (702) and a secondary pulse (704) in order to remove material (Forsman Patent, col. 12, line 65, to col. 13, line 64).

However, the Forsman Patent does not teach, or suggest, "each of the primary pulses has a length between fifty microseconds (50 μs) and one millisecond (1 ms)" as recited by claim 25 and "each of the secondary pulses has a length between one microsecond (1 μs) and twenty microseconds (20 μs)" as recited by claims 26 and 27.

ix. Summary of the Disclosures

The combination of the Kyusho Publication, the Wang Patent, the Yoda Patent, the Von Allmen Patent, the Freitas Patent, the Kuwabara Patent, the Tatsuno Patent and the Forsman Patent fails to teach, or suggest, (i) "said resonator generates primary pulses having a length within or greater than the microsecond range," (ii) "modulation means arranged between said resonator and a machining head, wherein said modulation means receives primary pulses from said resonator and operates to output a train of secondary pulses for each primary pulse entering therein from said resonator," and (iii) "each secondary pulse has a shorter length than the corresponding primary pulse" as recited by independent claims 12 and 29. The combination of the Kyusho Publication, the Wang Patent, the Yoda Patent, the Von Allmen Patent, the Freitas Patent, the Kuwabara Patent, the Tatsuno Patent and the Forsman Patent also fails to teach, or suggest, (iv) "each of the primary pulses has a length between fifty microseconds (50 μs) and one millisecond (1 ms)" as recited by claim 25, (v) "each of

the secondary pulses has a length between one microsecond (1 μs) and twenty microseconds (20 μs)" as recited by claims 26 and 27, and (vi) "said modulation means comprises a Pockels cell" as recited by claim 28.

For all of the above reasons, the Examiner has failed to establish a prima facie case of obviousness against claims 12-29 of the above-captioned application.

x. No Legitimate Reason to Justify the Combination of Disclosures and No Reasonable Expectation of Success of Obtaining Applicants' Claimed Invention Even if the Proposed Combination was Made

A proper rejection under Section 103 requires showing (1) that a person of ordinary skill in the art would have had a legitimate reason to attempt to make the composition or device, or to carry out the claimed process, and (2) that the person of ordinary skill in the art would have had a reasonable expectation of success in doing so. PharmaStem Therapeutics, Inc. v. ViaCell, Inc., 491 F.3d 1342, 1360 (Fed. Cir. 2007). In this case, the Examiner has failed to establish a prima facie case of obviousness against Applicants' claimed invention because the Examiner has not demonstrated a legitimate reason to make the proposed combination of disclosures and because the Examiner has failed to demonstrate that a person of ordinary skill in the art would have had a reasonable expectation of success even if the combination proposed by the Examiner was made.

More specifically, the Examiner's proposed combination of the Kyusho Publication, the Wang Patent, the Yoda Patent, the Von Allmen Patent, the Freitas Patent, the Kuwabara Patent, the Tatsuno Patent and the Forsman Patent falls way short of disclosing each and every limitation recited by claims 12-29 for all of the reasons discussed above. Therefore, it is clear that the Examiner is impermissibly using the claimed invention as the instruction manual or template to piece together isolated teachings of the prior art to deprecate the

claimed invention. In re Fritch, 23 U.S.P.Q.2d 1780. 1784 (Fed. Cir. 1992). This fact is even more clear with respect to the subject matter of independent claim 29 (previously claim 23), which the Examiner contends is "obvious" in view of no less than five (5) isolated patent disclosures (See Office Action, dated March 30, 2009, at 4, line 21, to 5, line 2), even though the combination of the five isolated disclosures falls way short of the subject matter of claim 29.

Furthermore, a person of ordinary skill in the art would have no reasonable expectation of success of arriving at a "laser machining device" as claimed that has the features wherein (i) the "resonator generates primary pulses having a length within or greater than the microsecond range," (ii) "modulation means arranged between said resonator and a machining head, wherein said modulation means receives primary pulses from said resonator and operates to output a train of secondary pulses for each primary pulse entering therein from said resonator," and (iii) "each secondary pulse has a shorter length than the corresponding primary pulse" as recited by independent claims 12 and 29, even if the combination of disclosure asserted by the Examiner was made. The device of claims 12 and 29 of the above-captioned application are characterized by a laser resonator arranged for generating primary pulses having a length within or greater than the microsecond range. Thus, the laser resonator provides primary pulses with a time length relatively long and having enough energy for drilling a hole in fluid injection devices. Accordingly, the laser resonator of the present invention is preferably not equipped with a Q-switch, which typically generates pulses in the nanometer range, in order to generate with standard laser equipment primary pulses within or greater than the microsecond range.

Furthermore, the laser machining device of claim 12 and of claim 29 includes modulation means arranged between the resonator and machining head, i.e. modulation means arranged downstream of the laser resonator. This modulation means modulates the

incoming laser beam (i.e. the primary pulses) so as to vary the power profile of each primary pulse such that secondary pulse trains of shorter length than the primary pulses are formed. The resulting pulse trains improve the efficiency and precision of the machining device in a manner which has not been disclosed and is not obvious in view of the Examiner's cited art.

For all of the above reasons, the Examiner has failed to establish a prima facie case of obviousness against claims 12-29 of the above-captioned application.

III. CONCLUSION

The Examiner has failed to establish prima facie case of obviousness against claims 12-29 because the combination of the Kyusho Publication, the Wang Patent, the Yoda Patent, the Von Allmen Patent, the Freitas Patent, the Kuwabara Patent, the Tatsuno Patent and the Forsman Patent fails to teach, or suggest, (i) "said resonator generates primary pulses having a length within or greater than the microsecond range," (ii) "modulation means arranged between said resonator and a machining head, wherein said modulation means receives primary pulses from said resonator and operates to output a train of secondary pulses for each primary pulse entering therein from said resonator," and (iii) "each secondary pulse has a shorter length than the corresponding primary pulse" as recited by independent claims 12 and 29.

For all of the above reasons, claims 12-29 are in condition for allowance and a prompt notice of allowance is earnestly solicited.

The below-signed attorney for Applicants welcomes any questions.

Respectfully submitted,

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